Sustainable biomass production

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Some definitions

Different definitions of biomass…

In Ecology, biomass is the total mass of living organisms measured in a population, or per area, or per other unit

Currently, biomass is often associated to the production of bioenergy

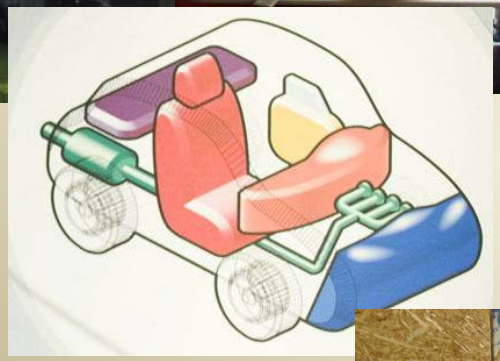
In Energy, this term includes all the organic matters able to produce energy either by direct combustion or after transformation.

This includes:

- wood (in logs, pellets or chips)
- by-products of wood from logging, sawmills and other wood processing industries
- by-products from industry (sludges, pulps, grape seeds…)
- products from conventional agriculture (cereals, oilseeds, stalks) + residues like straw, bagasse…
- organic waste such as municipal solid waste (sludges, garbages…)

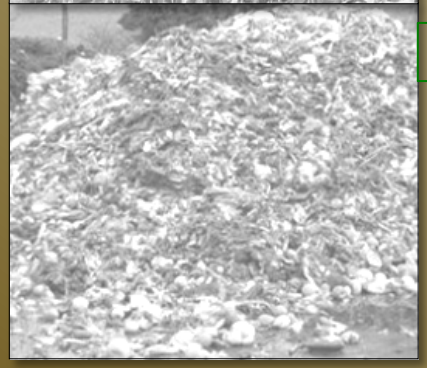
What biomass, what use ?

Hudge diversity of biomasses as well as their uses



Wheat

Biorefinery of wheat: Objective = using all the components of wheat



Cogeneration

Flour

Splitting

Cellulose | Lignines | Pentoses

Pulp / paper | Glues | Tensioactives products Detergents Degreasers…

Splitting

Starch | Glucose | Dextrose | Proteins | Solubles

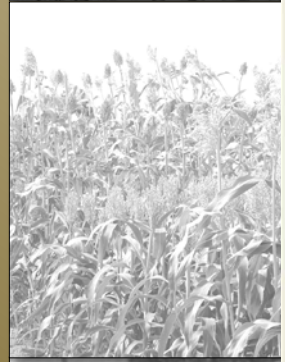
Glucose sirup Gl/Fr syrup | Hydrolyzed native gluten | Fibers, Fermentable substrats

Hyaluronic acid

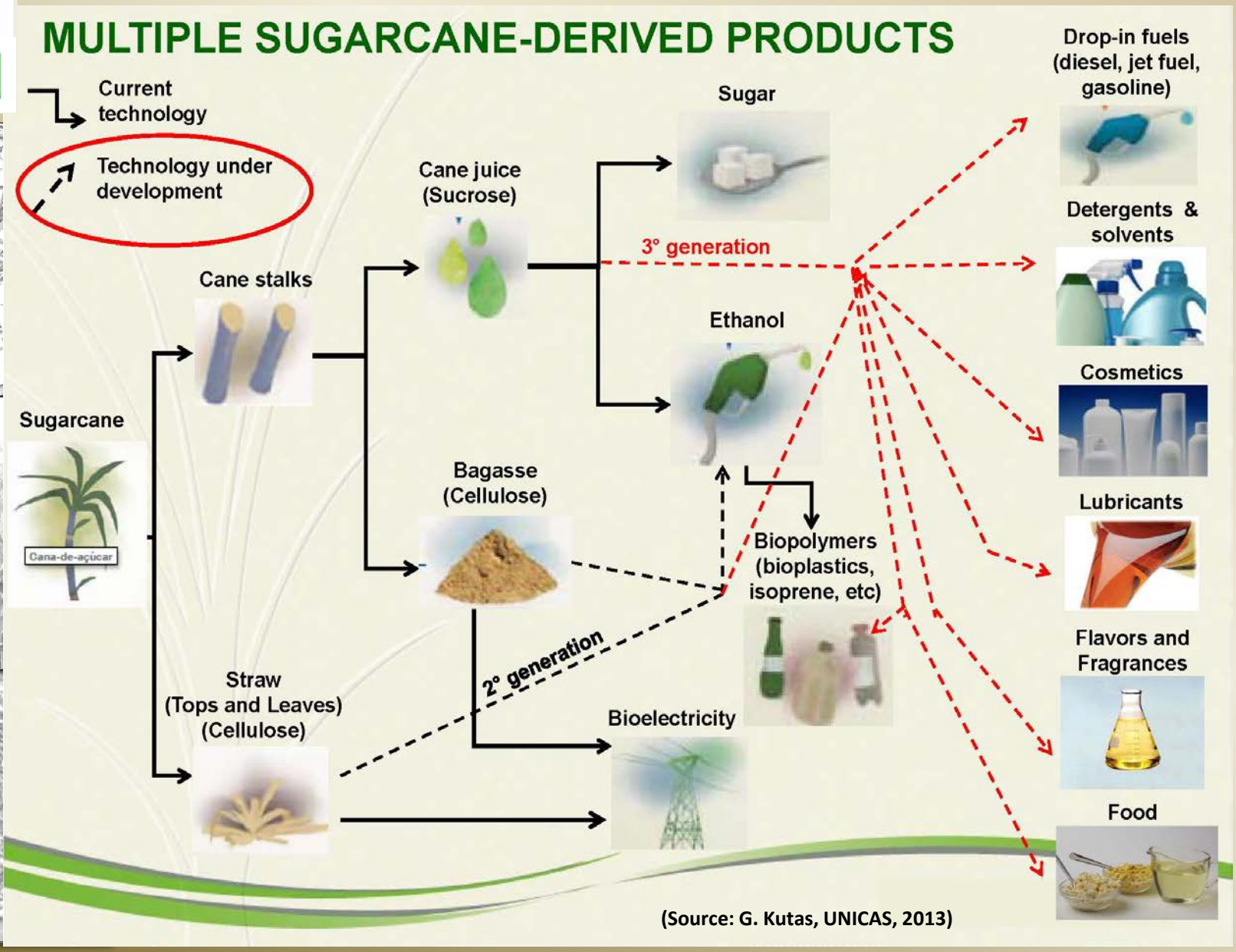
Succinic acid

Fermentation — Ethanol

Sugar cane



MULTIPLE SUGARCANE-DERIVED PRODUCTS



(Source: G. Kutas, UNICAS, 2013)

Sustainable biomass

Depending on the use, the quality of biomass is essential: case of sorghum for ethanol production

❶ **2nd generation EtOH** or **methane production :** a **biomass sorghum poor in lignin** to increase digestibility in that case,

Grain production is not essential

❷ **1st generation EtOH** and/or **cogeneration** (case of Brazil) **:** a **sweet sorghum** with **high biomass** + **high juice** + **high sugar** + bagasse **rich in lignin**

Grain production is not wishable

❸ **1st generation EtOH** combining **grain** and **fodder** (case of India): a **sweet sorghum** with high production f **grain** + **high biomass** + **high juice** + **high sugar** + bagasse **poor in lignin**

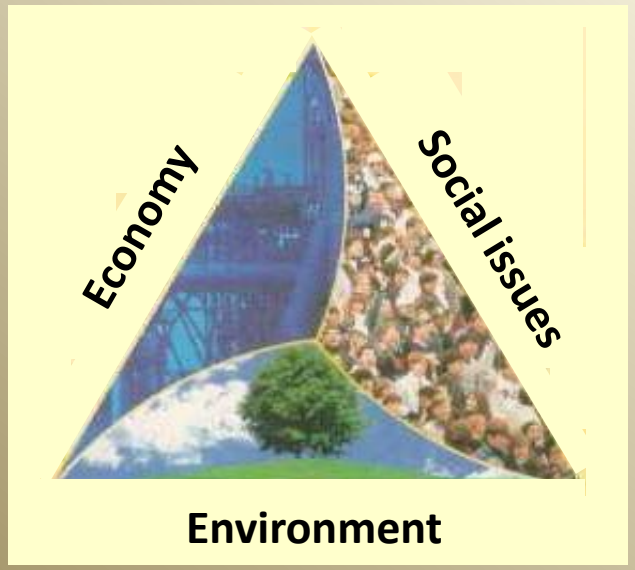
Grain production is essential

Sustainable biomass

Sustainability…

meeting the needs of the present generation without compromising the ability of future generations to meet their needs

Taking into account 3 pillars:



A sustainable energy from biomass

Focus on biomass for energy

6 criterias for assuming the sustainability

1. Economic prosperity: insight into possible negative effects on the regional and national economy

2. Avoid competition with food, as well as local energy, medicines and building materials

3. Well-being: no negative effects on the social well-being of workors and local population taking into account working conditions, human rights, property rights…

4. GHG balance: compared to fossil fuels, GHG reduction > 30%

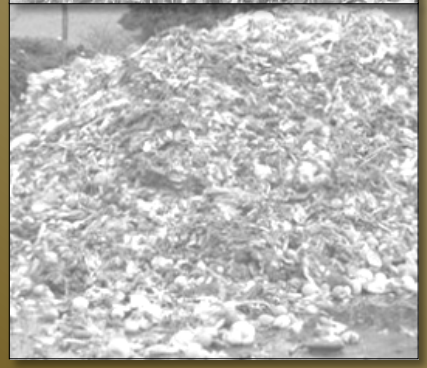
5. Biodiversity: no deterioration of protected area or valuable ecosystems

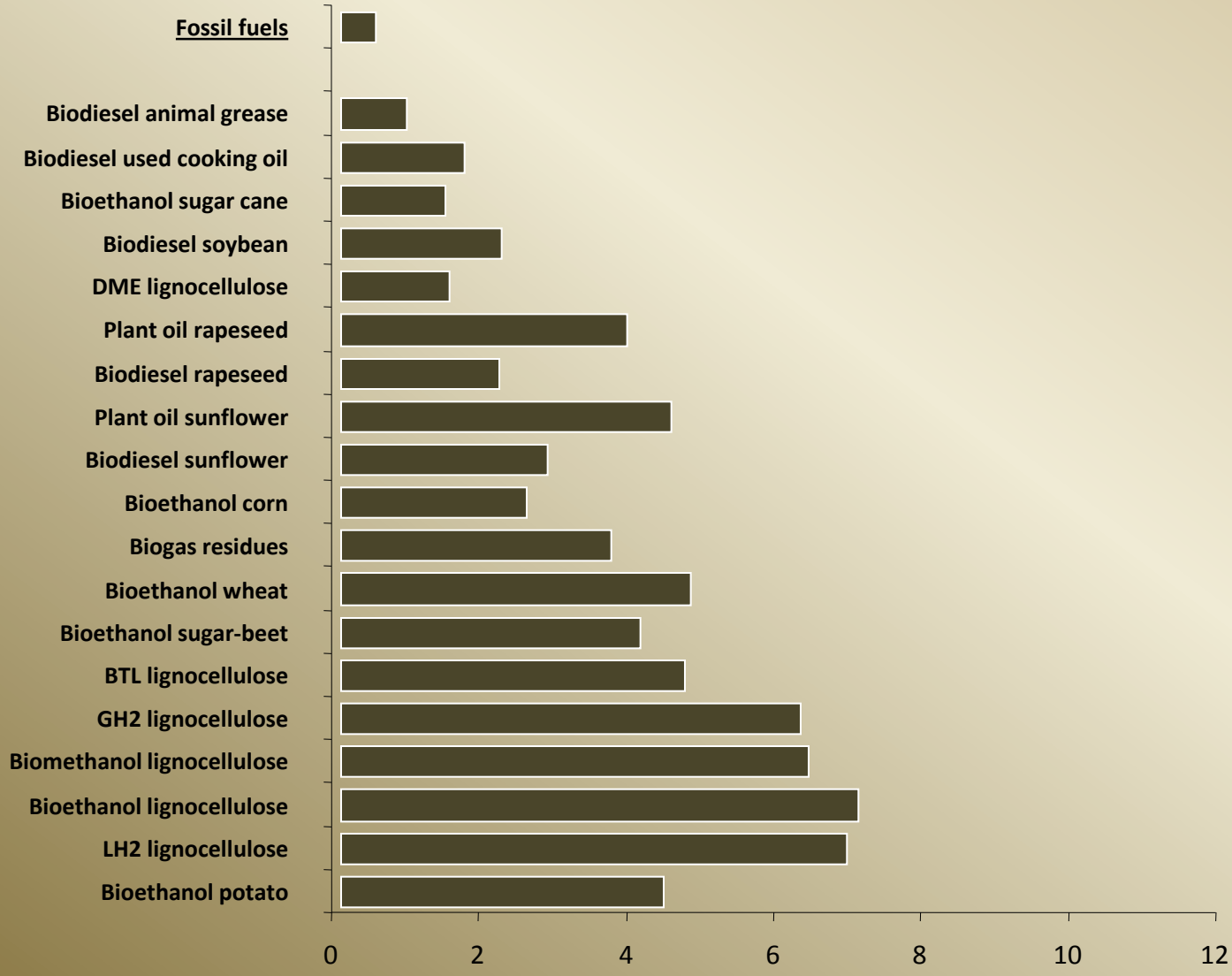
6. The environment: no negative effect taking into account waste management, use of agrochemicals, soil erosion, quality and quantity conservation of water ressource, emissions into air…)

Biofuels: economy point of view

Provision costs in Euro / 100 km

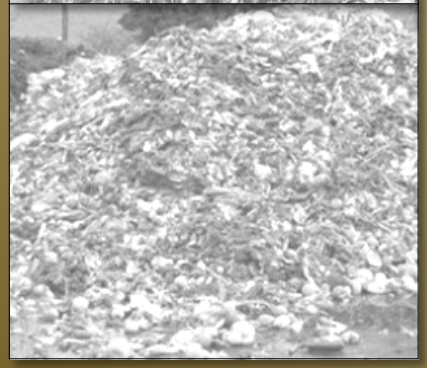
(Source: IFEU 2013)





Biofuels: economy point of view

CO2 avoidance costs



Field of measures	Costs (funding efficiency) (in Euro per tonne CO_2 saved)
• Driving manner	6
• Pellet heating	8
• Zero energy houses	12
• Vehicles	38
• Refrigerators	100
• Biofuels for transport	200
• Photovoltaic	500 – 1000

(Source: IFEU 2013)

- ⇨ **Biofuels are more costly than fossil fuels**
- ⇨ **There are many cost effective alternatives to save greenhouse gases**
- ⇨ **Need for incentives (tax reduction, directives et cetera) to enforce a biofuel market**

Biofuels: social aspects

Many criticisms of biofuels (and sometimes biomass energies)

- Induce a dramatic competition food/fuel
  and in some cases water shortage in rural areas due to water demand for biomass production…
- Require more lands for producing feedstocks
- Result in displacement of people, illegal land appropriation by producers…

Biofuels are not sustainable if social problems arise with local population

Biofuels: social aspects

But there can be also improvements of life through biofuels

- ⇨ Oil palm plantations : small holders = 40% of area
  40 families per km²
- ⇨ Create jobs
- ⇨ Social security
- ⇨ Increase of welfare
  (housing, medical care, …)
- ⇨ Represent a permanent income

⇨ ⇨ **There are many social aspects associated with biofuels and biomass production. Some of them have negative impacts, some have positive ones.**

Biofuels: environments

Negative impacts

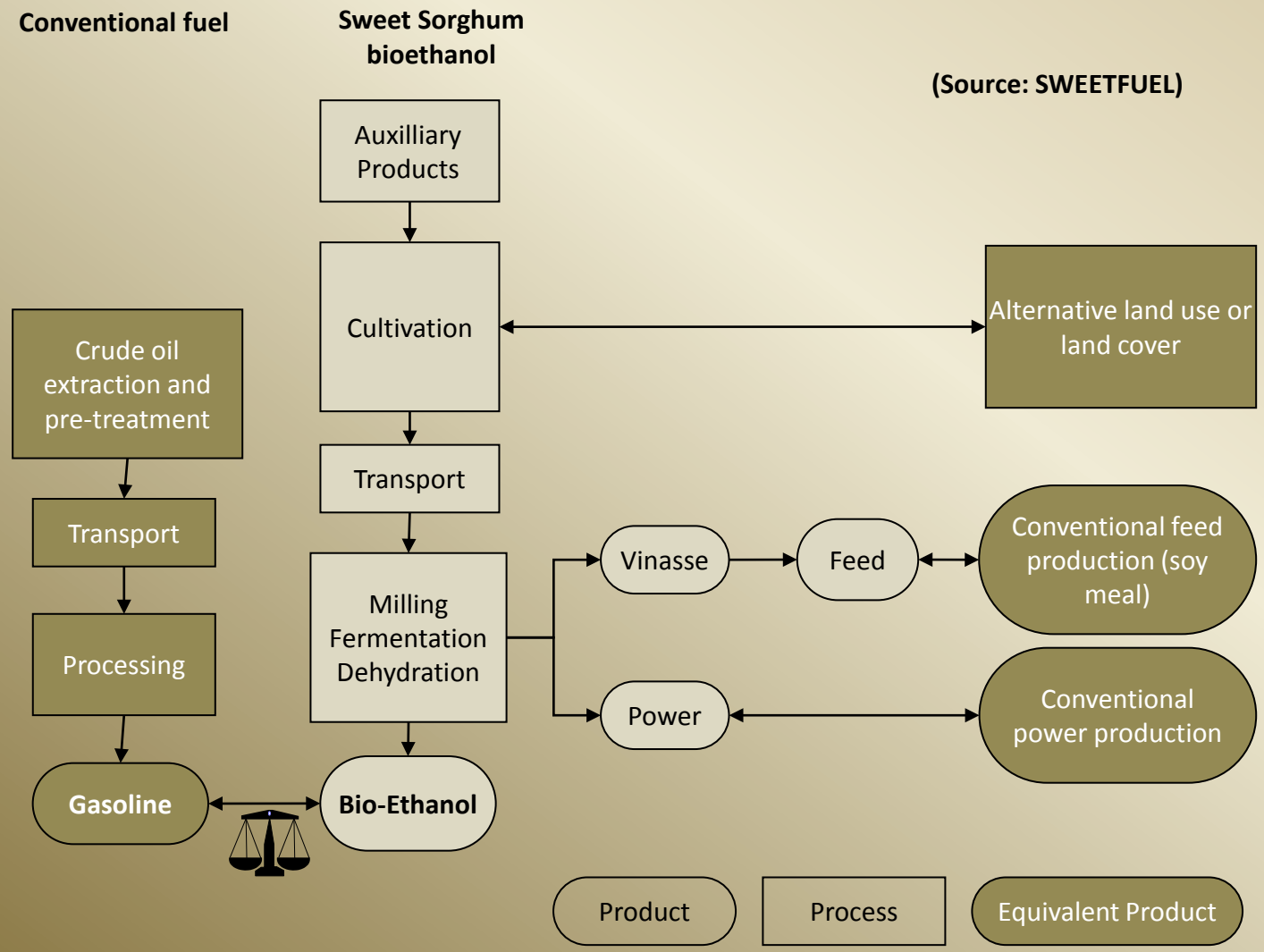
- Deforestation in Amazonia, Congo Basin, Indonesia, Malaysia…
- Impact on soils (erosion,…)
- Impact on water resource
- Effect on biodiversity: only 15% of the rain forest biodiversity reamin in an oil palm, oran utan, sumatra tiger… are threatened

Positive impacts

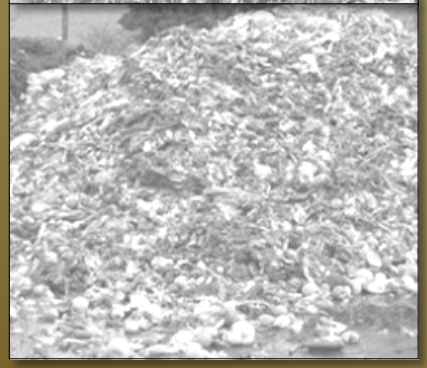
- Reduce GHG emission
- Climate change mitigation

Biofuels: environments

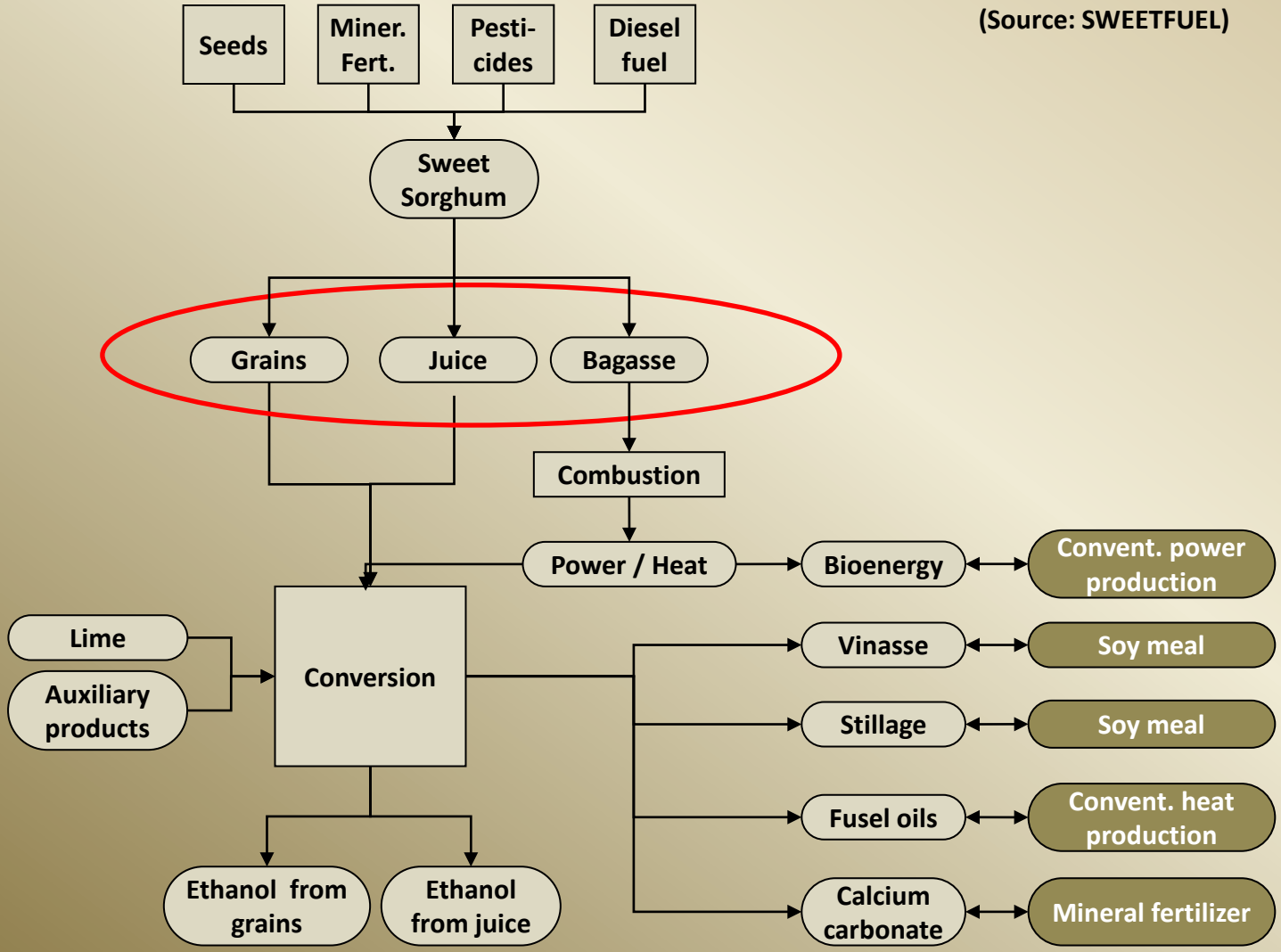
We need a frame for estimating positive and negative impacts: LCA
Estimation compared to a reference



Biofuels: environments



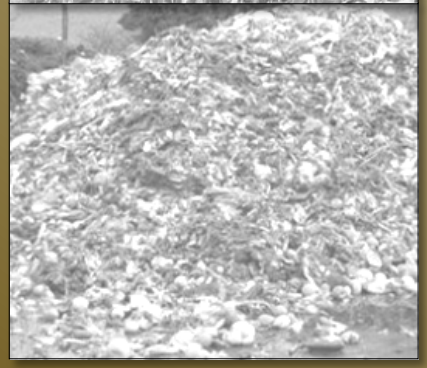
(Source: SWEETFUEL)

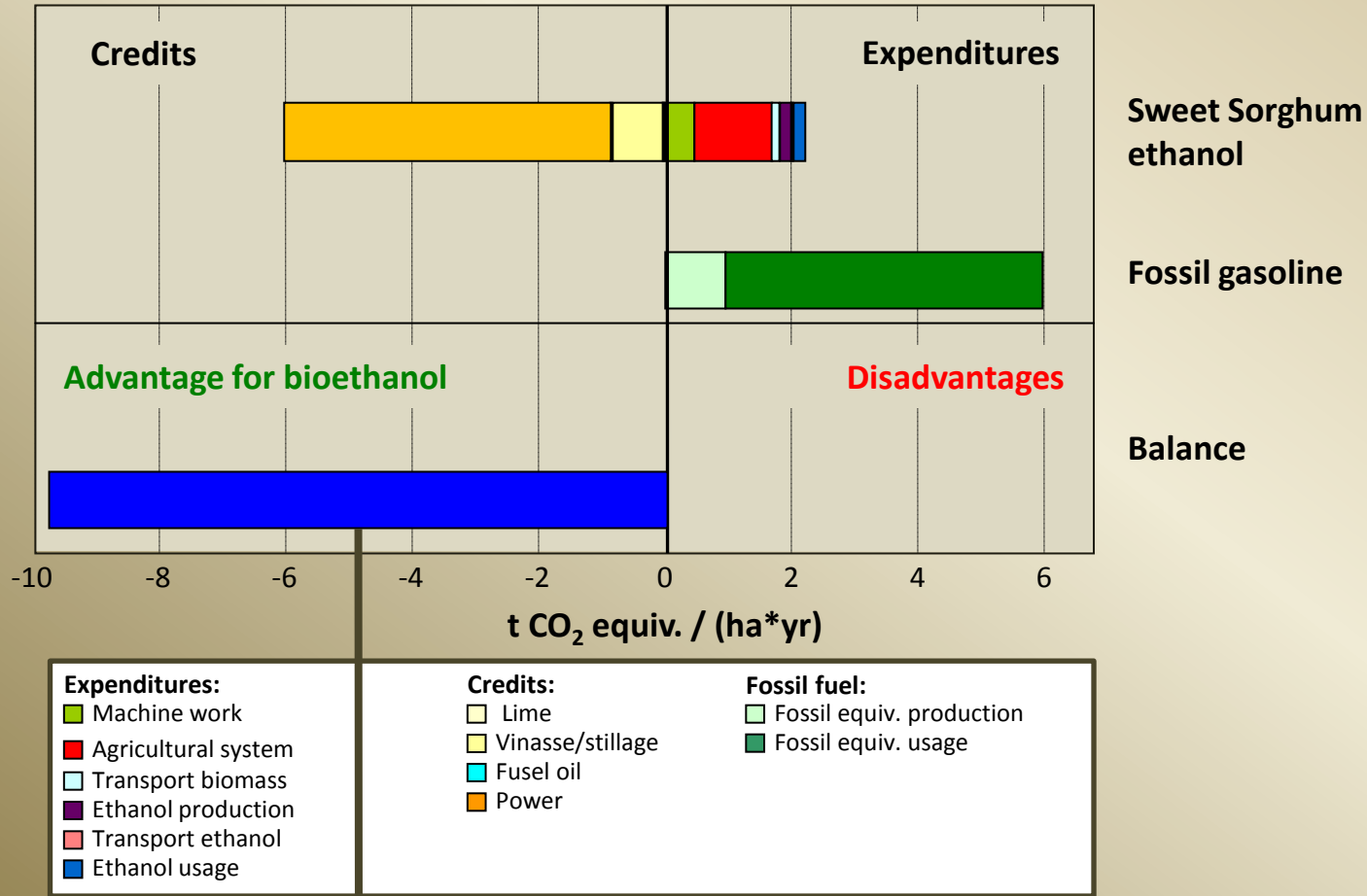


Biofuels: environments

Greenhouse effect

Source: IFEU 2009



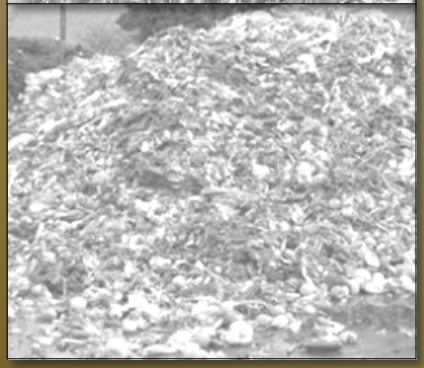


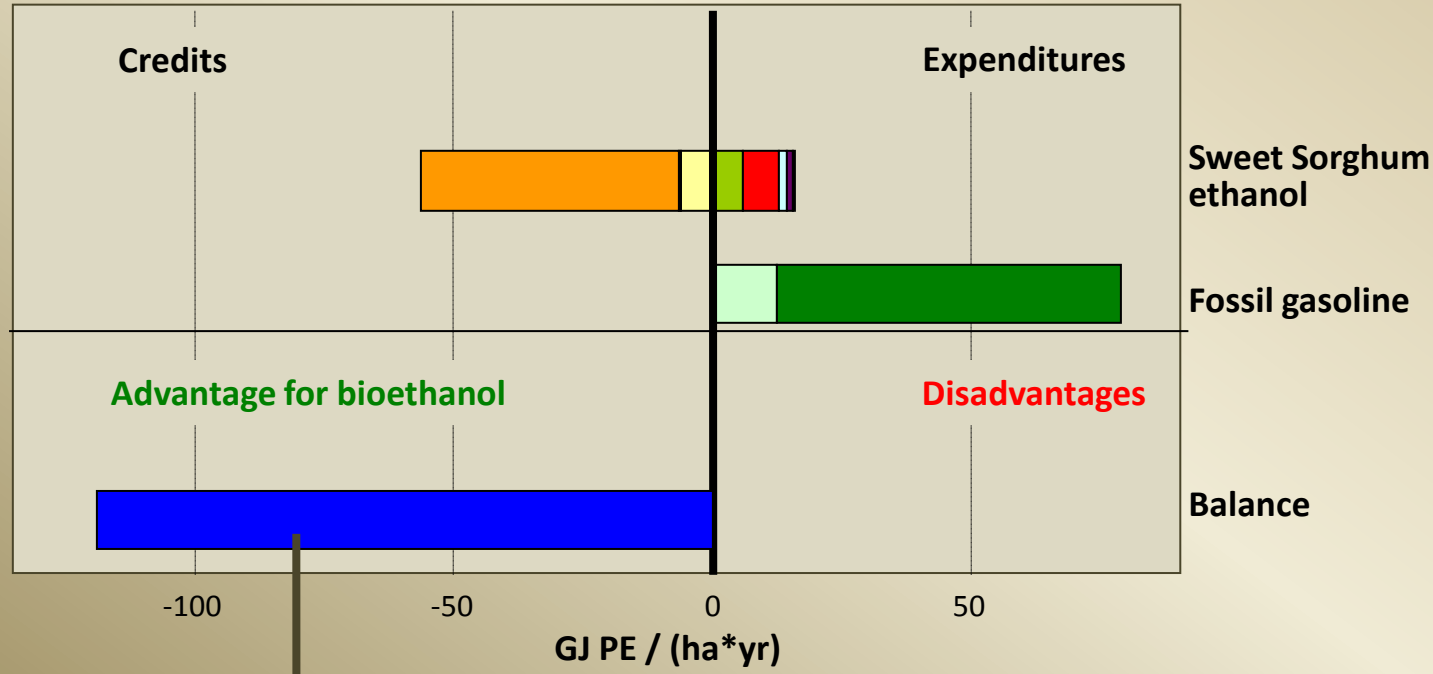
Equals a ride with a compact carof about 53 000 km (> perimeter of the Earth)

Biofuels: environments

Energy savings

(Source: IFEU 2009)





Expenditures:
- Machine work
- Agricultural system
- Transport biomass
- Ethanol production
- Transport ethanol
- Ethanol usage

Credits:
- Lime
- Vinasse/stillage
- Fusel oil
- Power

Fossil fuel:
- Fossil equiv. production
- Fossil equiv. usage

Equals a daily hours usage of a 40 Watt bulb for roundabout 98 years

Biofuels: environments

Different uses of sweet sorghum

(Source: IFEU 2009)

Grains ⇨ food, feed, fuel (1st G)

Juice ⇨ sugar, fuel (1st G)

Bagasse ⇨ Feed, pulp, bioenergy, fuel (2nd G) compost, fertilizer

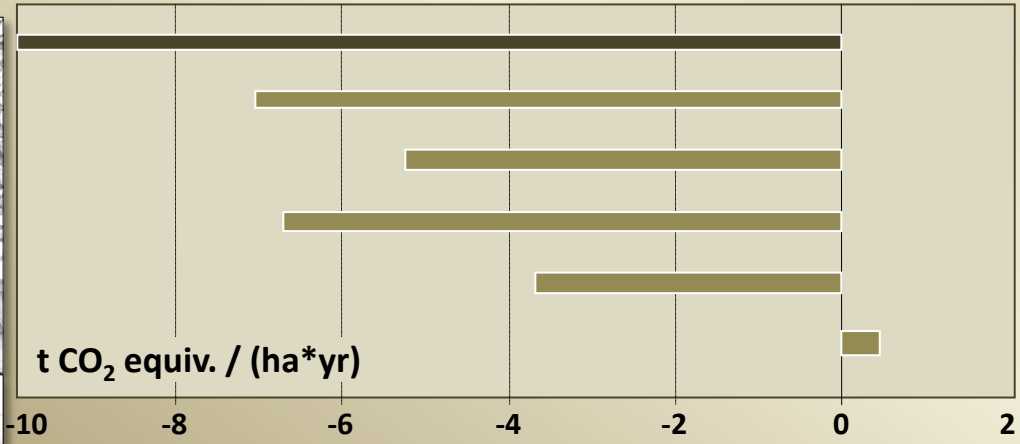
➡ Different scenarios

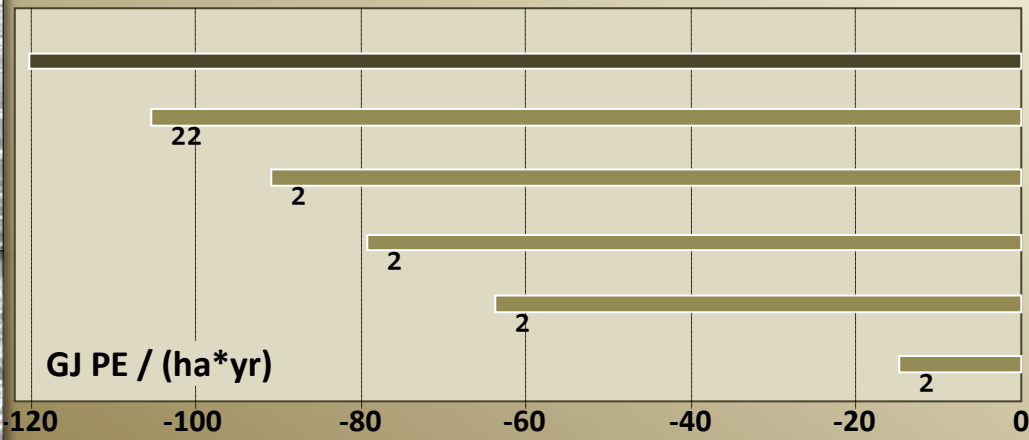
	Scenario	Juice	Grains	Bagasse
1	Standard	1st G EtOH2	1st G EtOH2	Process energy & bioelectricity
2	EtOH2 extended autarkic	1st G EtOH2	1st G EtOH2	2nd G EtOH2 (autarkic)
3	EtOH2 maximum fossil	1st G EtOH2	1st G EtOH2	2nd G EtOH2 (fossil fuel input)
4	Grains food	1st G EtOH2	Food	Process energy & bioelectricity
5	Food & EtOH 2	1st G EtOH2	Food	2nd G EtOH2 (autarkic)
6	Grains & juice food	Food (fossil fuel input)	Food	2nd G EtOH2 (autarkic)

Biofuels: environments

Sweet sorghum ethanol

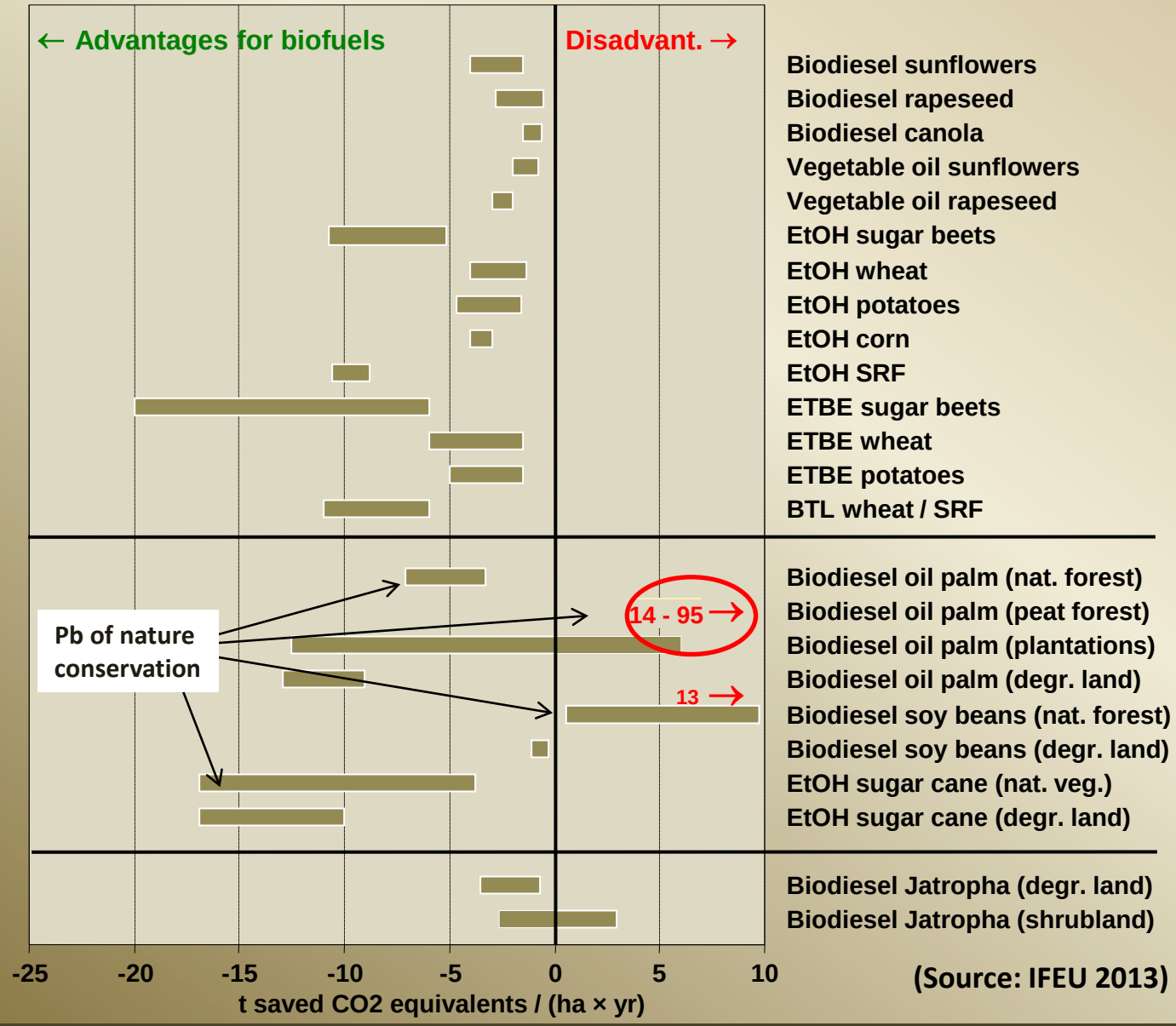
(Source: IFEU 2009)





The results of the environmental implications depend on the specific conditions.
Therefore, there is not only one result of an environmental assessment for sweet sorghum ethanol, but many.
Need for life cycle assessment to quantify the environmental implications.

Biofuels: environments / GHG balances

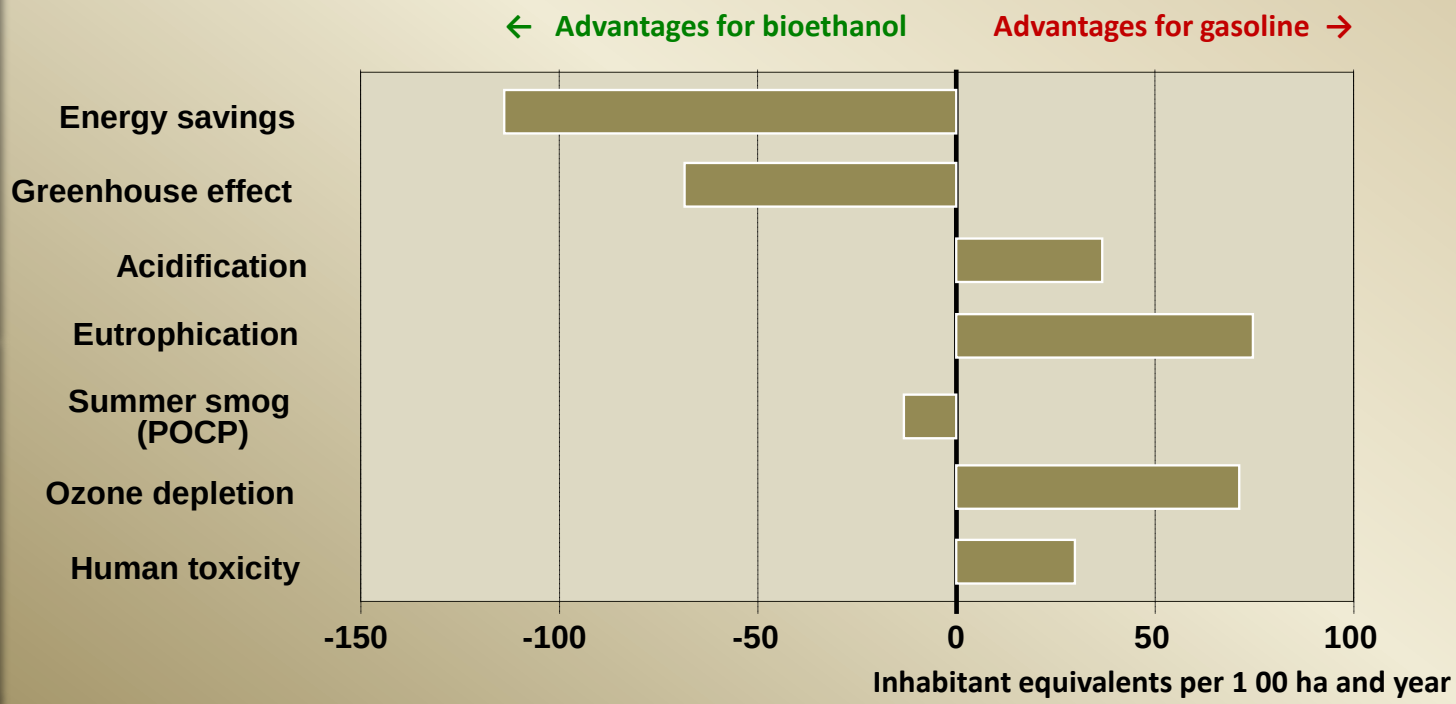


(Source: IFEU 2013)

Biofuels: environments

We have to go further !
Bioethanol from sugar beet versus gasoline

(Source: IFEU 2013)



Environmental advantages and burdens

Same pattern for most biofuels for transportation

Need to identify all environmental implications and optimise the advantages and minimise the disadvantages

Sutainable biomass

The sustainability of the biomass is quite complex to assess…

It depends on the:

- ⇨ nature of the biomass
- ⇨ process of its transformation
- ⇨ environment in which it is produced
- ⇨ uses

…

Biomass: the reserves are hudge and renewable…

Project "Biomass for the future" (BFF)

Coordinator: INRA - Institut Jean-Pierre Bourgin (IJPB) , Dr Herman HOFTE

Budget : Total = ~ 30 million € for a contribution from the government ~ 10 million €

Duration = 8 years (2013-2020)

24 partners: public institutions (INRA, CIRAD, Armines)
+ Private sector (from the sectors of breeding, thermoplastics coumpounds, cement, automotive parts, automotive, plant biotechnology etc..)
+ local authorities

2 objectives:

1. Development of local miscanthus (North of France) and sorghum biomass (South) production and valorization chains focused on heat-generation, anaerobic digestion and bio-based construction materials and plastics.

2. Creation of new varieties and culture systems for miscanthus and fiber sorghum, with improved lignocellulosic biomass yield, reduced environmental footprint and a composition tailored for industrial uses, including second generation biofuels and platform chemicals.

Thank you

Sweet Fuel

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